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REVIEW ARTICLE

Approaches to teaching evidence-based medicine in residency: a systematic review

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ABSTRACT

Background: Studies of evidence-based medicine (EBM) curricula in graduate medical education are common, but little consensus exists on the best methods to teach EBM.

Objective: The purpose of the current study was to evaluate EBM teaching approaches for graduate medical trainees and to update a 2014 systematic review.

Methods: We conducted a systematic literature search of major health and education databases for articles published from January 2014 through October 2022. Articles were independently screened to ensure they described an experimental or quasi-experimental evaluation of EBM teaching for graduate medical trainees. Quality of included studies was appraised using the Medical Education Research Study Quality Instrument. Data were extracted and synthesized using Coomarasamy and Khan's hierarchy of EBM teaching and learning.

Results: Over 1400 articles were screened; 35 met eligibility criteria and were included in our review. Interactive, classroom-based teaching approaches were most common (23/35, 66%). Only 2 (6%) studies used a clinically integrated teaching approach. Most studies reported positive short-term outcomes in EBM knowledge, skills, attitudes, or learner satisfaction. Few studies evaluated EBM behaviors, and none measured long-term application of EBM principles.

Conclusions: Reviewed studies had low to moderate study quality, often limited by small sample size and lack of validated measures. Although commonly encouraged as a teaching approach, few studies used clinically integrated EBM teaching. Instead of reporting individual, site-specific efforts, future studies should examine the broader culture of EBM in graduate medical education and prioritize sustained application of EBM into practice as a key outcome.

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Introduction

Evidence-based medicine (EBM) has become a pivotal approach to contemporary healthcare and involves the critical appraisal of medical research literature and its judicious application to clinical practice [1]. The Accreditation Council for Graduate Medical Education (ACGME) mandates successful understanding and application of EBM skills in residency through their Practice-Based Learning and Improvement core competency, which stresses the importance of locating, appraising, and assimilating scientific evidence [2]. Despite the increasing focus on EBM competencies during graduate medical training, trainees face numerous challenges to EBM learning and practice, such as insufficient time, limited knowledge, lack of skill, and a skeptical attitude toward EBM [3–5].

Although investigations of EBM curricula in graduate medical education are common, there is little consensus on the most effective approach for teaching EBM. Khan and Coomarasamy [6] proposed a hierarchical classification of EBM teaching and learning methods that ranged from interactive and clinically integrated activities (Level 1) to didactic or standalone activities (Level 3). However, whether and how this hierarchy informs EBM education in graduate medical training remains unclear. Teaching and learning EBM during graduate training is substantively different from medical school because of increased clinical and administrative responsibilities [7,8] and long duty hours that contribute to exhaustion and burnout [7,8]. Despite the heightened pressure and time constraints during graduate training, increased opportunities for independent practice may foster EBM decision-making and strengthen EBM habits.

Published evaluations of EBM education during residency or fellowship tend to be site- or specialty-

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specific, limiting their generalizability. Systematic reviews on this subject are either dated [7] or focus on specific educational strategies, such as journal clubs [8]. In 2014, Ilic and Maloney [9] conducted a systematic review of methods to teach EBM among graduate medical trainees, however their review was limited to randomized, controlled trials (RCTs) which are rare in medical education, and thus only included 9 studies over a 20-year period.

The purpose of the current systematic review was to evaluate EBM teaching approaches for graduate medical trainees. We used Ilic and Maloney's 2014 systematic review [9] as a baseline, but expanded the scope to include study designs that are more common in medical education, such as pretest-posttest designs. Therefore, our goal was to evaluate current experimental or quasi-experimental evidence to determine how EBM education approaches were associated with EBM knowledge, skills, attitudes, and behaviors. Expanding the review beyond RCTs provides a more comprehensive picture of the current evidence. Ideally, results from this review will build on past research, address current gaps in knowledge, and inform future research in this area.

Materials and methods

This systematic review was conducted according to the JBI Manual for Evidence Synthesis [10] and adhered to reporting standards established by the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA). Further, we developed our study protocol according to the PRISMA-Protocol (PRISMA-P) extension [11] and registered our review in Open Science Framework (https://doi.org/10.17605/OSF.IO/FXMDE). Prior to starting the review, all available medical education databases and Google Scholar were searched to ensure that a study addressing this research question had not been published after 2014, as this review updates and expands upon of the systematic review performed by Ilic and Maloney in 2014 [9]. The study was considered a nonjurisdiction project by the A.T. Still University Institutional Review Board in May 2022.

Search strategy

For the current systematic review, we conducted a literature search of major health and education databases for articles published from January 2014 through October 2022 that investigated EBM teaching approaches for graduate medical trainees. The exact search strategy used in the Ilic and Maloney systematic review [9] was not available for reproduction, so a medical librarian (A3) developed our search strategy in PubMed, including PMC (PubMed Central) and MEDLINE in the strategy (Supplementary Material). To ensure the search strategy was comprehensive, it was peer-reviewed using the Peer Review of Electronic Search Strategies 2015 Guideline Statement (PRESS) [12]. Our strategy was then translated to search in the following EBSCO platform databases: CINAHL (Cumulative Index to Nursing and Allied Health Literature) Plus Full Text, ERIC (Education Resources Information Center), and Education Source. Searches in these databases were completed individually using controlled vocabulary (Supplementary Material). Google and Google Scholar were also searched using our original search strategy. The initial searches in all databases were performed on 15 October 2022.

Our search strategy also included grey literature. In addition to searching the Chronicle of Higher Education website and the *Journal of Graduate Medical Education*, we searched the following databases: Education Abstracts, ProQuest Dissertation and Theses Global, the Networked Digital Library of Theses and Dissertations, Open Access Theses and Dissertations, Database of Abstracts of Reviews of Effects, and Health Technology Assessment. Citation and reference chaining from all reviewed studies was conducted manually. The three most common journals of reviewed studies were also hand searched: *Advances in Medical Education and Practice*, *PRiMER*, and *Journal of Surgical Education*. We also hand-searched *Academic Medicine* and the *Journal of Medical Education and Curricular Development* because of their relevance to our topic. Our search strategy did not involve contacting authors, experts, or others to identify additional studies. Deduplication was performed using Covidence review software, which is a web-based platform for systematic and other reviews.

Eligibility criteria

To be included, studies had to be in English, have an experimental or quasi-experimental design, and involve medical residents or fellows. Studies from the grey literature, theses and dissertations, and preprints were also eligible for inclusion. Studies with no control group or no comparison to baseline, such as posttest only designs, were excluded. Studies with mixed populations, such as residents and faculty, that did not report graduate medical trainees' results separately, were also excluded. The EBM teaching approaches used could include any single one or combination of the following: lecture, workshops, small groups, case-based or problem-based learning, online learning, or clinical application. Studies were required to report 1 or more of the following EBM outcomes: knowledge, skills, attitudes, or behaviors.

Because our review was an update and expansion of Ilic and Maloney [9], studies published before 2014 were excluded.

Two investigators (A1 and A2) independently screened titles and abstracts of all identified articles using the Covidence software, and a third researcher (A3) served as a blinded tie-breaker for any screening disagreements. This same process was used for full-text screening of articles to determine inclusion in the final sample.

Quality assessment

Several instruments are available to assess quality of medical education research. We chose the 10-item Medical Education Research Study Quality Instrument (MERSQI), because it has been established as reliable and valid, especially when standardized operational criteria are used, and emphasizes objective assessment [13]. Scores on the MERSQI range from 5–18, with higher scores indicating higher study quality. Standard operational criteria were established by all authors for MERSQI items. Two authors (A1 and A2) collaboratively scored 15% of included studies to establish calibration before independently assessing the remaining studies. For studies with fewer than 3 item discrepancies between raters, the average of the two raters' scores was used. For studies with three or more item discrepancies between raters, the third author (A3) served as a tie-breaker to reach consensus.

Data extraction

Data were extracted by the first author (A1) using a data extraction tool developed by the study team for the current review (Supplementary Material). Extracted data included study design, educational intervention, number of sessions, and sample size. Outcomes extracted included EBM knowledge, skills, attitudes, behaviors, and learner satisfaction. The extraction tool was documented in the protocol a priori and finalized after full-text and quality review. The first author (A1) piloted and refined the data extraction tool for 20% of included studies to ensure the tool was complete prior to data extraction. The study protocol was updated in Open Science Framework in January 2024, prior to data extraction.

Results of data extraction were synthesized by study characteristics, EBM educational approach, study outcomes, and study quality. Educational approaches were categorized according to the hierarchy developed by Coomarasamy and Khan [6,14], where 1 was the highest quality and 3 the lowest. Specifically, Level 1 approaches were interactive and clinically integrated, Level 2a approaches were interactive and classroom-based, Level 2b approaches were didactic and clinically integrated, and Level 3 approaches were didactic and classroom-based. When educational interventions did not fit these categories, the approach was classified as other.

Results

Search strategy

Our initial search identified 1416 articles; 146 duplicates were removed (Figure 1). Titles and abstracts of 1270 articles were screened, and 65 were considered eligible for full-text review. Thirty articles did not meet inclusion criteria during full-text review and were excluded. Thirty-five studies met inclusion criteria and were included in our quality review and data extraction (Table 1) [15–49].

Study characteristics

Table 1 reports characteristics of the 35 reviewed studies, which involved over 1250 participants from various medical specialties. Most (71%, 25) studies were conducted in the United States, and 66% (23) used convenience sampling of a single class or cohort. The number of sessions ranged from 1–3 (6%, 2) to more than 5 (71%, 25). All but 1 study used a quasi-experimental design with, predominantly, pretest-posttest comparisons of a single group. The experimental design study was a 5-year, longitudinal investigation comparing a program-level surgery EBM curriculum across several cohorts of students [27].

Twenty-eight (80%) studies assessed EBM knowledge (20 using objective and 8 self-report). Participants' EBM skills were assessed in 13 studies (37%, 11 objective, 2 self-report). Only two studies assessed EBM behaviors (Table 1). In those 2 studies, Dasgupta et al. [22] measured EBM behaviors using faculty-reported number of evidence citations used by residents in practice, and Richardson et al. [36] measured EBM behaviors through self-report and objective review of residents' documentation in patient charts. Attitudes toward EBM were assessed in 12 (37%) studies, and learner satisfaction with the educational approach was assessed in 14 (40%).

Educational approaches and study outcomes

Study outcomes by educational approach are reported in Table 2. Only 2 studies [15,16] used Level 1 interactive and clinically integrated educational approaches activities. Al Saiegh et al. [15] used North American Spine Surgery criteria in an EBM curriculum focused on lumbar surgery best practices for 18 neurosurgery residents and 1 neurosurgery fellow. After a training module, participants held weekly group reviews for 1 year to discuss current

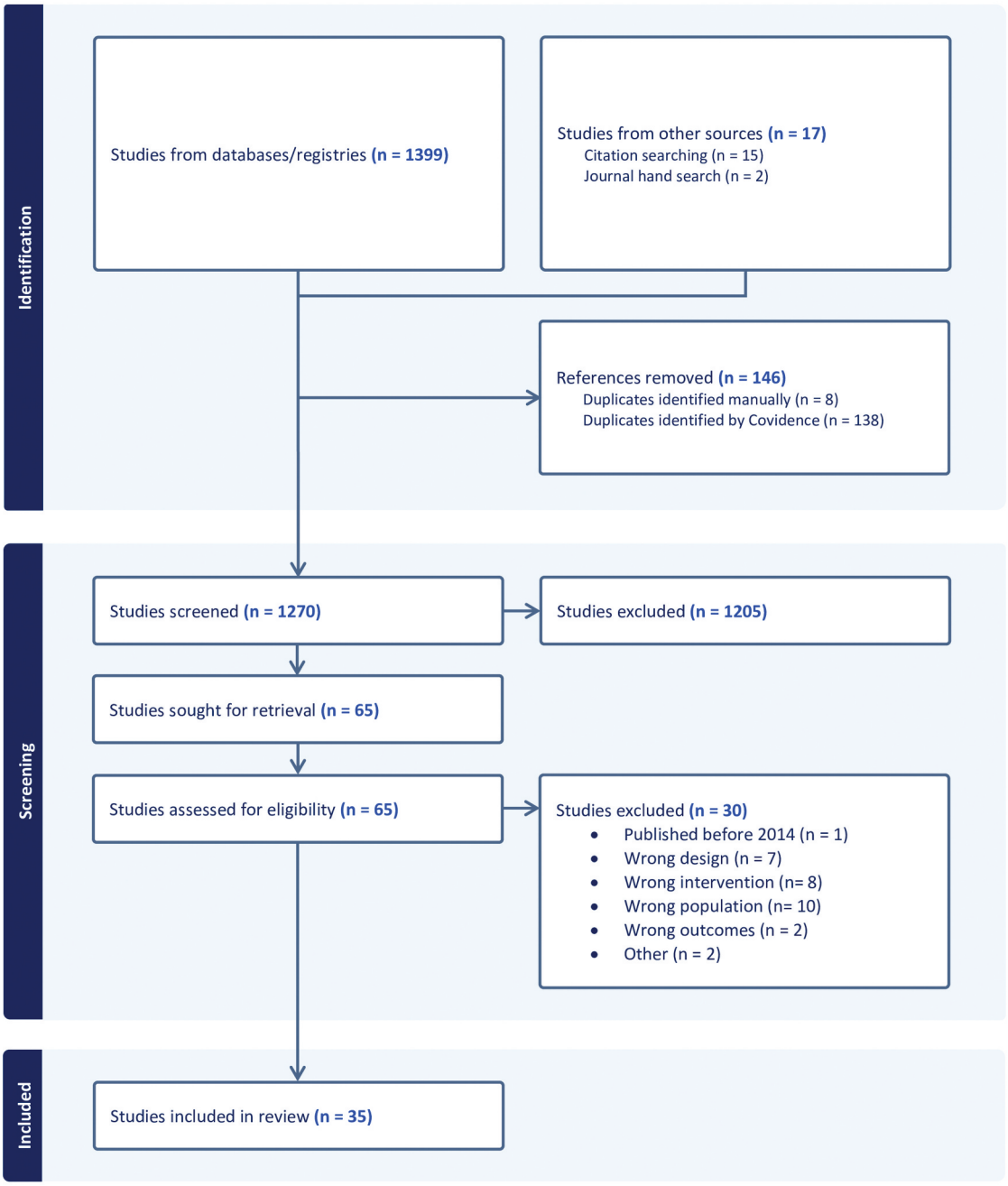

Figure 1. PRISMA Diagram Illustrating Selection and Review Process of Articles Evaluating Educational Methods to Teach Evidence-Based Medicine.

lumbar fusion cases in relation to the guidelines, explain why they thought surgery was performed, and document cases where they thought surgery should not be performed [15]. Aneese et al. [16] implemented an EBM curriculum for 60 internal medicine residents during a single academic year. The curriculum included monthly workshops and journal clubs, weekly senior morning reports, and monthly chief rounds on current clinical cases [16]. Both studies [15,16] required learners to apply EBM principles to current clinical cases that directly informed real patient care, and both reported statistically significant improvements in EBM knowledge and skills on objective posttests. However, attitudes toward EBM, long-term retention of EBM concepts, and sustained application of EBM behaviors were not assessed in either study. Although Aneese et al. [16] collected learner satisfaction data, that information was qualitative and difficult to quantify.

Level 2a classroom-based interactive approaches were examined in 23 (66%) studies, making this the most common approach (Table 2) [17–39]. Among these Level 2a approaches, one-third of studies used a journal club as the primary educational format [18,19,23,24,26,28–30]. Examples of interactive learning activities included conducting literature searches, engaging in critical appraisals of articles, presenting evidence on a specific case or topic, and participating in small-group work. Regarding EBM outcomes, 83% (19) of studies examining Level 2a approaches

Table 1. Characteristics and outcomes of reviewed studies by educational approach category ($N = 35$).

Author(s), Year, Location	Trainees and Setting	Approach, No. Sessions	MERSQI Score[a]	Outcomes Assessed (Direction of Effect)
Level 1 Educational Approaches (Interactive and Clinically Integrated)				
Al Saiegh et al. [15], United States	19 Surgery residents from 1 institution	Didactic lectures >5 sessions	11.5	Objective knowledge (↑) Objective skills (↑)
Aneese et al. [16], United States	19 Internal medicine residents from 1 institution	Workshops >5 sessions	13.75	Objective knowledge (↑) Objective skills (↑) Learner satisfaction (↑)
Level 2a Educational Approaches (Interactive but Classroom-Based)				
Al Achkar et al. [17], United States	40 Family medicine residents from multiple cohorts at 1 institution	Small group bootcamp 4–5 sessions	11	Objective knowledge (↑) Objective skills (↑) EBM attitudes (unchanged)
Alavi-Moghaddam et al. [18], Iran	50 Emergency/trauma residents from 1 institution	Journal club >5 sessions	15	Objective knowledge (↑) Objective skills (↑)
Allon et al. [19], United States	61 Internal medicine residents from > 1 institution	Journal club >5 sessions	14.25	Objective skills (↑)
Chitkara et al. [20], United States	8–23 Pediatric residents per year from multiple cohorts at 1 institution	Small-group sessions >5 sessions	9.25	Self-reported knowledge (↑) EBM attitudes (↑)
Collins et al. [21], Canada	165 Internal medicine residents from multiple cohorts at 1 institution	Workshops >5 sessions	6.5	Self-reported knowledge (↑) Learner satisfaction (↑)
Dasgupta et al. [22], United States	>50 Pediatric residents from 1 institution	Seminars, morning reports, noon conferences >5 sessions	13	Self-reported knowledge (↑) EBM attitudes (↑) Self-reported EBM behaviors (↑) Learner satisfaction (↑)
Duong et al. [23], United States	7 Otolaryngology residents from 1 institution	Journal club >5 sessions	8.5	Learner satisfaction (↑) Self-reported skills (↑)
Faridhosseini et al. [24], Iran	18 Psychiatry residents from > 1 institution	Journal club >5 sessions	10	Self-reported knowledge (↑)
Halalau et al. [25], United States	10 Internal medicine residents from 1 institution	Didactic lectures, small groups, team-based learning, self-directed learning, resident-to-resident teaching >5 sessions	6.25	Self-reported knowledge (↑) Learner satisfaction (↑)
Herur et al. [26], India	30 Residents in multiple specialties and cohorts from 1 institution	Journal club 1–2 sessions	13.5	Objective knowledge (↑) Objective skills (↑)
Komenaka et al. [27], United States	30 Surgery residents from multiple cohorts at 1 institution	Faculty mentorship, structured discussions >5 sessions	11	Objective knowledge (↑) Learner satisfaction (↑)
Luc et al. [28], United States	4 Surgery fellows from 1 institution	Journal club >5 sessions	10	Self-reported knowledge (↑) Learner satisfaction (↑)
Luc et al. [29], United States	30 Surgery fellows from > 1 institution	Journal club >5 sessions	12.5	Self-reported knowledge (↑) Learner satisfaction (↑)
Mohr et al. [30], United States	14 Emergency/trauma residents	Journal club >5 sessions	13.5	Objective knowledge (unchanged) Objective skills (unchanged)
Nasr et al. [31], United States	25 Internal medicine and medicine-pediatric residents from 1 institution	Workshops >5 sessions	11	Objective knowledge (↑) Objective skills (↑)
Nelson et al. [32], United States	60 Pediatric residents from 1 institution	Didactic lectures, workshops using the MAARIE framework 4–5 sessions	14.75	Objective knowledge (↑) EBM attitudes (↑)
Pammi et al. [33], United States	14 Neonatal fellows from 1 institution	Didactic lectures, small Groups >5 sessions	13.75	Objective knowledge (↑) Objective skills (↑)
Paulet Juncà et al. [34], Switzerland	42 Pediatric residents from 1 institution	Team-based learning 1 session	13	Objective knowledge (↑) EBM attitudes (↑) Learner satisfaction (↑)
Ramaswamy et al. [35], United States	12 Geriatrics and palliative medicine fellows from 1 institution	Didactic lectures, group discussion, case-based learning, EBM practice with coaching and feedback >5 sessions	11.25	EBM attitudes (↑) Learner satisfaction (mixed)
Richardson et al. [36], United States	22 Cardiology fellows from 1 institution	Small and large group sessions, short didactic and group discussions 4–5 sessions	11.75	Objective knowledge (↑) Objective EBM behaviors (↑)
Song et al. [37], United States	21 Family medicine residents from multiple cohorts at 1 institution	Group sessions during noon conferences >5 sessions	11.5	EBM attitudes (↑) Learner satisfaction (↑)
Tavarez et al. [38], United States	22 Emergency/trauma fellows from 1 institution	Online modules, individual coaching, group sessions >5 sessions	13	Objective knowledge (↑)
Ubbink et al. [39], The Netherlands	89 Surgery residents from multiple cohorts at 1 institution	Didactic lectures, workshops 2–3 sessions	14	Objective knowledge (↑)
Level 2b Educational Approaches (Didactic and Clinically Integrated)				
Lycan et al. [40], United States	14 Medical oncology fellows from 1 institution	Oncology case documentation, review sessions >5 sessions	12.5	Objective skills (unchanged) Learner satisfaction (↑)
Level 3 Educational Approaches (Didactic, Classroom-Based)				

(*Continued*)

Table 1. (Continued).

Author(s), Year, Location	Trainees and Setting	Approach, No. Sessions	MERSQI Score[a]	Outcomes Assessed (Direction of Effect)
Bastaninejad et al. [41], Iran	41 Otolaryngology residents from 1 institution	Workshops >5 sessions	13.75	Objective knowledge (↑) Objective skills (↑)
Bentley et al. [42], United States	54 Emergency/trauma residents from > 1 institution	Journal club >5 sessions	13.75	Objective knowledge (↑) Objective skills (↑)
Goodarzi et al. [43], Iran	69 Medical residents from 1 institution	Didactic lectures >5 sessions	14	Objective knowledge (mixed) EBM attitudes (mixed) Learner satisfaction (mixed)
Sadeghi et al. [44], Iran	78 Internal medicine residents from 1 institution	Journal club >5 sessions	8.5	Self-reported knowledge (↑) Learner satisfaction (↑)
Stewart et al. [45], United States	44 Pediatric residents from 1 institution	Didactic lectures 4–5 sessions	11	Objective knowledge (↑) EBM attitudes (mixed)
Trickey et al. [46], United States	40 Surgery residents from multiple cohorts at 1 institution	Didactic lectures 4–5 sessions	13	Objective knowledge (↑)
Other Educational Approaches				
Clesham et al. [47], Ireland	13 Surgery residents from 1 institution	Journal club >5 sessions	11.75	Objective knowledge (↑) EBM attitudes (↑)
Hahn et al. [48], United States	10 Family medicine residents from 1 institution	Distribution of curricular tool (TEACH Cards) 0 sessions	7.5	EBM attitudes (↑)
Hahn et al. [49], United States	14 Family medicine residents from 1 institution	Distribution of curricular tool (TEACH Cards) 0 sessions	9	Self-reported skills (mixed) EBM attitudes (unchanged)

Abbreviations: ↑, improved; EBM, evidence-based medicine; MAARIE, method, assignment, assessment, results, interpretation, and extrapolation; MERSQI, Medical Education Research Study Quality Instrument; TEACH, Teaching EBM and Clinical topics in the Hospital. [a]MERSQI scores range from 5–18, with higher scores indicating higher study quality.

assessed knowledge [17,18,20–22,24–34,36,38,39,44]% (10) assessed learner satisfaction [21–23,25,27–29,34,35,37, 35]% (8) assessed skills [17–19,23,26,30,31,33], and 30% (7) assessed attitudes [17,20,22,32,34,35,37] (Table 2). Among the 23 Level 2a studies, 87% (20) [18–29,31–34,36–39] reported improvements in all measured outcomes, while 13% (3) [17,30,35] reported mixed or unchanged results on at least one outcome. Only 2 (9%) studies [22,36] assessed short-term EBM behaviors, but neither evaluated sustained application of EBM.

Only one study [40] used a Level 2b didactic and clinically integrated approach (Table 2). Lycan et al. [40] implemented a quality improvement project for fellows that required them to actively contribute evidence to an online database for oncology tumour board meetings. Didactic review sessions were held after quality improvement revisions to the database [40]. Although Lycan et al. [40] reported that learner satisfaction was favorable, EBM knowledge, behaviors, and attitudes were not assessed, and the skills of fellows for adding evidence to the database did not improve over time.

Six studies [41–46] used Level 3 classroom-based didactic approaches (Table 2). Five of these studies [41,42,44–46] reported increases in knowledge, but most results for skills, attitudes, behaviors, and learner satisfaction were either unchanged, mixed, or not assessed. Two used a journal club as the primary educational method [42,44], and one used didactic lecture sessions [43].

Three reviewed studies [47–49] had educational approaches that were categorized as other. Two evaluated voluntary use of an EBM clinical tool distributed to participants [48,49], and one reviewed an asynchronous, virtual journal club using WhatsApp [47].

Study quality

Total MERSQI scores of the 35 reviewed studies ranged from 6.25 to 15, with a median of 11.75, consistent with medical education research on non-EBM topics [13]. The diversity of outcome measures makes it challenging to directly compare quality across studies, but MERSQI results do provide insights into common methodological limitations, which can inform future research. For example, a sample size of less than 30 participants ($n = 16$) and lack of validated measures ($n = 14$) were the two most common quality limitations. Similarly, among the 7 studies with a MERSQI score below 10, all relied on either subjective knowledge assessment, attitudes, and/or learner satisfaction rather than objective outcomes. There were fewer than 3 MERSQI item discrepancies between raters for 29 (83%) studies; interrater reliability for these studies was strong ($r = 0.83$, $p > .001$). For the 6 studies with 3 or more MERSQI item discrepancies between raters, the third author (A3) served as a tie-breaker to reach consensus.

Discussion

This systematic review evaluated EBM teaching approaches for graduate medical trainees. Our study updates and expands upon of the 2014 systematic review by Ilic and Maloney [9], which evaluated EBM teaching methods for undergraduate and graduate medical trainees. Ilic and Maloney limited their review to RCTs, yielding only 9 over 20 years. However, our review was more expansive, including experimental and quasi-experimental

Table 2. Summary of study outcomes of reviewed studies by categorized level of evidence-based medicine (EBM) educational approach ($N = 35$).

	Educational Approach				
EBM Outcome	Level 1 Interactive and Clinically Integrated ($n = 2$)	Level 2a Interactive and Classroom-Based ($n = 23$)	Level 2b Didactic and Clinically Integrated ($n = 1$)	Level 3 Didactic and Classroom-Based ($n = 6$)	Other[a] ($n = 3$)
EBM knowledge					
Improved	2	17	0	5	1
Unchanged or mixed	0	2	0	1	0
Not assessed	0	4	1	0	2
EBM skills					
Improved	2	6	0	2	0
Not improved or mixed	0	1	1	4	1
Not assessed	0	16	0	0	2
EBM attitudes					
Improved	0	6	0	0	2
Unchanged or mixed	0	1	0	2	1
Not Assessed	2	16	1	4	0
EBM behaviors					
Improved	0	2	0	0	0
Unchanged or mixed	0	0	0	0	0
Not assessed	2	21	1	6	3
Learner satisfaction					
Favorable	1	10	1	1	0
Unchanged or mixed	0	1	0	0	0
Not assessed	1	12	0	5	3

[a]When educational interventions did not fit defined level categories, the approach was classified as other.

designs to better reflect the most common designs used in medical education. Among 1270 studies screened, 35 met inclusion for our review [15–49] Results indicated common methodological limitations, such as small sample sizes and lack of consistent or validated measures. Further, all but 4 studies were conducted at a single site, included a single cohort of medical residents or fellows, used unstandardized educational approaches, or involved pretest-posttest designs. These factors limited the internal validity and generalizability of the reviewed studies.

Overall, our results supported the conclusions of previous research. For example, methodological limitations of studies in our review were consistent with other systematic reviews [7–9]. Similar to Ilic and Maloney [9], several factors limited our ability to identify which EBM educational approaches were most effective. These factors included lack of variability in the hierarchy [6,14] of educational approaches across studies, lack of validated or objective measures for outcomes, and lack of assessment of EBM behaviors.

Interactive, clinically integrated teaching and learning of EBM have been promoted as more effective than standalone, didactic approaches detached from clinical settings [6,7,14,50]. However, our review highlighted a lack of research investigating interactive, clinically integrated EBM education; only 2 of the 35 reviewed studies examined this approach. Classroom-based approaches with an interactive component were much more common and included such tasks as structuring clinical questions, locating and appraising evidence, and engaging in critical discourse on case scenarios. Although teaching EBM in a classroom-based setting is logistically feasible, some argue it has questionable or mixed educational value [51–53]. Further, our results indicated that, while most classroom-based interactive approaches had favorable short-term outcomes, EBM behaviors and long-term assimilation of EBM into practice were rarely assessed. Thus, firm conclusions cannot be made about the long-term effectiveness of these approaches on clinical practice.

In addition to improving educational outcomes like EBM knowledge, clinically integrated approaches may reduce skepticism of trainees regarding feasibility and utility of EBM, which has been reported as a barrier to EBM learning and practice [3–5]. Clinically integrated training approaches move beyond finding and appraising evidence toward communicating evidence to patients in lay language. This communication supports treatment decisions that balance best available evidence, clinical expertise, and patient values [54]. In this respect, clinically integrated EBM education can also reinforce the ACGME's core competencies of Interpersonal and Communication Skills and Patient Care [2]. However, the lack of research on clinically integrated approaches deserves attention, as it may suggest important constraints in time or resources that make these approaches impractical for most programs. If clinically integrated approaches are unrealistic, a re-evaluation of Coomarasamy and Khan's hierarchy of EBM teaching and learning methods may be warranted. In addition, reports from programs that have successfully established clinically integrated EBM training would be informative.

Beyond evaluation of specific EBM teaching approaches, studies have emphasized the importance of fostering a program-level culture of EBM [4,55,56], which is challenging given the lack of regular assessment of EBM skills in graduate medical training (in comparison to clinical skills, for example). Although additional research on site-specific EBM education efforts may be informative, research should be broadened to consider the residency program culture as a whole. Fortunately, measures such as the EBM Environment Scale are available to empirically assess contextual factors affecting EBM learning and practice [55]. Supporting a culture of EBM requires easy access to meaningful resources and infrastructure, including sufficient faculty experts, access to medical librarians and biostatisticians, and protected time for EBM learning and application [4]. A culture of EBM also requires a critical mass of faculty mentors who support and model EBM [55]. Ultimately, EBM curricula will be ineffective if residents perceive a lack of interest in, infrequent use of, or low regard for EBM among faculty [3,4,50].

The current systematic review had potential limitations that may limit the generalizability of our findings. In our effort to balance the specificity and sensitivity of the search terms in this strategy, there may be terms we did not include, resulting in overlooked studies. In addition, we only included studies that had at least a quasi-experimental design, so our results do not consider potential insights from descriptive or qualitative studies. Finally, while the MERSQI is an established, valid, and reliable instrument to assess study quality, it is limited in allowing direct comparison between studies using diverse samples and designs such as those included in our review. The MERSQI also does not specifically evaluate potential bias. A Modified Medical Education Research Study Quality Instrument (MMERSQI) has recently been developed that better assesses potential bias [57]. Once the MMERSQI is established as reliable and valid, future systematic reviews may be strengthened by using this updated instrument.

Conclusions

Results of our review suggested graduate medical programs approached EBM curricula in a variety of ways but relied largely on classroom-based rather than clinically integrated approaches, perhaps because the latter are more difficult and less feasible to implement. Although learning results in the reviewed studies were generally favorable, higher-level and longer-term outcomes, such as assimilation of EBM into practice, were rarely assessed. In addition, studies were limited by small sample sizes and inconsistent use of validated measures. Future work is warranted to explore the role of a program-level culture of EBM, as well as strategies to feasibly offer clinically integrated EBM training. In addition, future research would benefit from more robust sample sizes, consistent use of validated measures, and longer-term assessment of outcomes. These efforts will foster better understanding of effective EBM education and practice among graduate medical trainees.

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Author contributions

All authors gave final approval to the submitted manuscript. Kathleen Mathieson (KM) was responsible for conception. KM, Megan Weemer (MW), and Laura Lipke (LL) were involved in design, analysis, and interpretation of evidence. KM and MW were responsible for review of evidence for inclusion and quality appraisal, and LL was the tie breaker for determination of evidence inclusion. LL developed and completed the literature search strategy.

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References

[1] Sackett DL, Rosenberg WM, Gray J, et al. Evidence based medicine: what it is and what it isn't. BMJ. 1996;312(7023):71–72. doi: 10.1136/bmj.312.7023.71

[2] Accreditation Council for Graduate Medical Education (ACGME). The program directors' guide to the common program requirements (residency). Published July 2021 [cited 2024 19]. Available from: https://dl.acgme.org/courses/the-program-directors-guide-to-the-common-program-requirements-residency-ebook

[3] Bhandari M, Montori V, Devereaux PJ, et al. Challenges to the practice of evidence-based medicine during residents' surgical training: a qualitative study using grounded theory. Acad Med. 2003;78(11):1183–1190. doi: 10.1097/00001888-200311000-00022

[4] Epling JW, Heidelbaugh JJ, Woolever D, et al. Examining an evidence-based medicine culture in residency education. Fam Med. 2018;50(10):751–755. doi: 10.22454/FamMed.2018.576501

[5] van Dijk N, Hooft L, Wieringa-de Waard M. What are the barriers to residents' practicing evidence-based medicine? A systematic review. Acad Med. 2010;85(7):1163–1170. doi: 10.1097/ACM.0b013e3181d4152f
[6] Khan KS, Coomarasamy A. A hierarchy of effective teaching and learning to acquire competence in evidenced-based medicine. BMC Med Educ. 2006;6(1):1–9. doi: 10.1186/1472-6920-6-59
[7] Coomarasamy AK, Khalid S. What is the evidence that postgraduate teaching in evidence based medicine changes anything? A systematic review. BMJ. 2004;329(7473):1–5. doi: 10.1136/bmj.329.7473.1017
[8] Ahmadi N, McKenzie ME, MacLean A, et al. Teaching evidence based medicine to surgery residents—Is journal club the best format? A systematic review of the literature. J Surg Educ. 2012;69(1):91–100. doi: 10.1016/j.jsurg.2011.07.004
[9] Ilic D, Maloney S. Methods of teaching medical trainees evidence-based medicine: a systematic review. Med Educ. 2014;48(2):124–135. doi: 10.1111/medu.12288
[10] Aromataris E, Munn Z, editors. JBI manual for evidence synthesis. JBI; 2020 [cited 2024 Mar 19]. doi: 10.46658/JBIMES-20-01
[11] Moher D, Shamseer L, Clarke M, et al. Preferred reporting items for systematic review and meta-analysis protocols (PRISMA-P) 2015 statement. Syst Rev. 2015;4(1):1. doi: 10.1186/2046-4053-4-1
[12] McGowan J, Sampson M, Salzwedel DM, et al. PRESS peer review of electronic search strategies: 2015 guideline statement. J Clin Epidemiol. 2016;75:40–46. doi: 10.1016/j.jclinepi.2016.01.021
[13] Cook DA, Reed DA. Appraising the quality of medical education research methods: the medical education research study quality instrument and the Newcastle-Ottawa scale-education. Acad Med. 2015;90(8):1067–1076. doi: 10.1097/ACM.0000000000000786
[14] Maggio LA. Educating physicians in evidence based medicine: current practices and curricular strategies. Perspect Med Educ. 2016;5(6):358–361. doi: 10.1007/s40037-016-0301-5
[15] Al Saiegh F, Philipp L, Hughes LP, et al. The impact of incorporating evidence-based guidelines for lumbar fusion surgery in neurosurgical resident education. World Neurosurg. 2021;154:e382–e388. doi: 10.1016/j.wneu.2021.07.045
[16] Aneese AM, Nasr J, Halalau A. A prospective mixed-methods study evaluating the integration of an evidence based medicine curriculum into an internal medicine residency program. Adv Med Educ Pract. 2019;10:533–546. doi: 10.2147/amep.s203334
[17] Al Achkar M. Redesigning journal club in residency. Adv Med Educ Pract. 2016;7:317–320. doi: 10.2147/AMEP.S107807
[18] Alavi-Moghaddam M, Yazdani S, Mortazavi F, et al. Evidence-based medicine versus the conventional approach to journal club sessions: which one is more successful in teaching critical appraisal skills? Chonnam Med J. 2016;52(2):107–111. doi: 10.4068/cmj.2016.52.2.107
[19] Allon S, Baggett A, Hayes B, et al. Association of a gamified journal club on internal medicine residents' engagement and critical appraisal skills. J Grad Med Educ. 2023;15(4):475–480. doi: 10.4300/JGME-D-22-00812.1
[20] Chitkara MB, Boykan R, Messina CR. A longitudinal practical evidence-based medicine curriculum for pediatric residents. Acad Pediatr. 2016;16(3):305–307. doi: 10.1016/j.acap.2015.12.013
[21] Collins C, Mathura P, Ip S, et al. Applying improvement science to establish a resident sustained quality improvement (QI) educational model. BMJ Open Qual. 2021;10(1):e001067. doi: 10.1136/bmjoq-2020-001067
[22] Dasgupta MN, Kirkey DC, Weatherly JA, et al. Using self-determination theory to drive an evidence-based medicine curriculum for pediatric residents: a mixed methods study. Acad Pediatr. 2021;22(3):486–494. doi: 10.1016/j.acap.2021.12.018
[23] Duong MN, Strumpf A, Daniero JJ, et al. Redesigning journal club to improve participant satisfaction and education. J Surg Educ. 2022;79(4):964–973. doi: 10.1016/j.jsurg.2022.01.011
[24] Faridhosseini F, Saghebi A, Khadem-Rezaiyan M, et al. Effect of changing journal clubs from traditional method to evidence-based method on psychiatry residents. Adv Med Educ Pract. 2016;7(NA):483–487. doi: 10.2147/amep.s110036
[25] Halalau A, Falatko J, Mi M. Application of adult learning theory in teaching evidence based medicine to residents. J Med Educ. 2016;15(4):185–193.
[26] Herur A, Kolagi S, Ramadurg U, et al. Refining the journal club presentations of postgraduate students in seven clinical departments for better evidence-based practice. Ann Med Health Sci Res. 2016;6(3):185–189. doi: 10.4103/2141-9248.183939
[27] Komenaka IK, Heberer MA, O'Neill PJ, et al. The effect of an evidence-based medicine curriculum on breast cancer knowledge and satisfaction of surgical residents. J Surg Educ. 2015;72(4):717–725. doi: 10.1016/j.jsurg.2014.12.017
[28] Luc JGY, Nguyen TC, Fowler CS, et al. Novel debate-style cardiothoracic surgery journal club: results of a pilot curriculum. Ann Thorac Surg. 2017;104(4):1410–1416. doi: 10.1016/j.athoracsur.2017.05.072
[29] Luc JGY, Fowler CS, Eisenberg SB, et al. Multiinstitutional evaluation of a debate-style journal club for cardiothoracic surgery trainees. Ann Thorac Surg. 2022;114(1):327–333. doi: 10.1016/j.athoracsur.2021.07.104
[30] Mohr NM, Stoltze AJ, Harland KK, et al. An evidence-based medicine curriculum implemented in journal club improves resident performance on the Fresno test. J Emerg Med. 2015;48(2):222–229.e1. doi: 10.1016/j.jemermed.2014.09.011
[31] Nasr JA, Falatko J, Halalau A. The impact of critical appraisal workshops on residents' evidence based medicine skills and knowledge. Adv Med Educ Pract. 2018;9:267–272. doi: 10.2147/amep.s155676
[32] Nelson B, Ingard C, Nelson D. Teaching trainees how to critically evaluate the literature: a crossover study at two pediatric residency programs. Int J Med Educ. 2017;8:137–141. doi: 10.5116/ijme.58ce.5f04
[33] Pammi M, Lingappan K, Carbajal MM, et al. Focused evidence-based medicine curriculum for trainees in neonatal-perinatal medicine. MedEdPORTAL. 2017;13:10664. doi: 10.15766/mep_2374-8265.10664
[34] Paulet Juncà G, Belli D, Bajwa NM. Team-based learning to contextualise evidence-based practice for residents. Med Educ. 2017;51(5):542–543. doi: 10.1111/medu.13297
[35] Ramaswamy R, Leipzig RM, Hung WW. Implementation of an evidence-based medicine curriculum in a fellowship program: can it influence

clinical practice? Gerontol Geriatr Educ. 2020;43 (1):92–101. doi: 10.1080/02701960.2020.1777409
[36] Richardson KM, Singh J, Muñoz D, et al. Improving practice guideline adherence through peer feedback: impact of an ambulatory cardiology curriculum. Teach Learn Med. 2018;30(3):328–336. doi: 10.1080/10401334.2017.1415811
[37] Song C, Porcello L, Hernandez T, et al. Description and evaluation of an evidence-based residency curriculum using the evidence-based medicine environment survey. Fam Med. 2022;54(4):298–303. doi: 10.22454/fammed.2022.652106
[38] Tavarez MM, Kenkre TS, Zuckerbraun N. Evidence-based medicine curriculum improves pediatric emergency fellows' scores on in-training examinations. Pediatr Emerg Care. 2020;36(4):182–186. doi: 10.1097/pec.0000000000001185
[39] Ubbink DT, Legemate DA, Koelemay MJ. The merits of a two-day evidence-based medicine course for surgical residents. World J Surg. 2016;40(8):1809–1814. doi: 10.1007/s00268-016-3495-0
[40] Lycan TW, Ahmed T, Seegars MB, et al. An evidence-based medicine approach for case presentations by trainees. Clin Teach. 2019;16(6):575–579. doi: 10.1111/tct.12978
[41] Bastaninejad S, Soltani A, Dabiran S, et al. Determining effectiveness of EBM education in otolaryngology residents using modified Fresno test. Laryngoscope. 2019;129 (10):2291–2294. doi: 10.1002/lary.27762
[42] Bentley S, Slovis BH, Shah K. Introduction of a novel evidence-based medicine curriculum in emergency medicine. Med Sci Educ. 2018;28(3):497–501. doi: 10.1007/s40670-018-0575-9
[43] Goodarzi H, Teymourzadeh E, Rahimi S, et al. Efficacy of active and passive evidence-based practice training for postgraduate medical residents: a non-randomized controlled trial. BMC Res Notes. 2021;14(1):317. doi: 10.1186/s13104-021-05732-3
[44] Sadeghi A, Biglari M, Nasseri-Moghaddam S, et al. Medical journal club as a new method of education: modifications for improvement. Arch Iran Med. 2016;19(8):556–560.
[45] Stewart D, Lye C, Lopez M, et al. Engaging learners through modules in quality improvement and patient safety. MedEdPORTAL. 2016;12:10482. doi: 10.15766/mep_2374-8265.10482
[46] Trickey AW, Crosby ME, Singh M, et al. An evidence-based medicine curriculum improves general surgery residents' standardized test scores in research and statistics. J Grad Med Educ. 2014;6(4):664–668. doi: 10.4300/JGME-D-14-00117
[47] Clesham K, Piggott RP, Sheehan E. A prospective review of a novel electronic journal club format in an orthopedic residency unit. J Surg Educ. 2019;77 (1):115–123. doi: 10.1016/j.jsurg.2019.08.018
[48] Hahn TW, D'Agata C, Edgoose J, et al. TEACH cards: teaching evidence-based medicine and clinical topics in the hospital. PriMER. 2018;2:25. doi: 10.22454/primer.2018.479320
[49] Hahn TW, Regner C, Metzger E, et al. OB-Newborn TEACH cards: a curricular tool for maternal-child rotations that influences patient care. PriMER. 2022;6:2. doi: 10.22454/primer.2022.716258
[50] Young T, Rohwer A, van Schalkwyk S, et al. Patience, persistence and pragmatism: experiences and lessons learnt from the implementation of clinically integrated teaching and learning of evidence-based health care—a qualitative study. PLOS ONE. 2015;10(6):e0131121. doi: 10.1371/journal.pone.0131121
[51] Franklin CC, Bosch PP, Grudziak JS, et al. Does a weekly didactic conference improve resident performance on the pediatric domain of the orthopaedic In-training examination? J Pediatr Orthop. 2017;37 (2):149–153. doi: 10.1097/BPO.0000000000000726
[52] Meyer NB, Gaetke-Udager K, Shampain KL, et al. (Lack of) measurable clinical or knowledge gains from resident participation in noon conference. Acad Radiol. 2018;25(6):719–726. doi: 10.1016/j.acra.2017.12.032
[53] McDonald FS, Zeger SL, Kolars JC. Associations between United States medical licensing examination (USMLE) and internal medicine In-training examination (IM-ITE) scores. J Gen Intern Med. 2008;23 (7):1016–1019. doi: 10.1007/s11606-008-0641-x
[54] Wieten S. "What the patient wants": an investigation of the methods of ascertaining patient values in evidence-based medicine and values-based practice. J Eval Clin Pract. 2018;24(1):8–12. doi: 10.1111/jep.12471
[55] Mi M, Moseley JL, Green ML. An instrument to characterize the environment for residents' evidence-based medicine learning and practice. Fam Med. 2012;44(2):98–104.
[56] Mi M. Factors that influence effective evidence-based medicine instruction. Med Ref Serv Q. 2013;32 (4):424–433. doi: 10.1080/02763869.2013.837733
[57] Al Asmri M, Haque MS, Parle J. A modified medical education research study quality instrument (MMERSQI) developed by delphi consensus. BMC Med Educ. 2023;23(1). doi: 10.1186/s12909-023-04033-6